

# **The U.S. Government is the Biggest Single User of GPS; Has Invested at Least \$43 Billion in It**

*Sampling provides snapshot of U.S. government investments in GPS; Information incomplete and actual figure is almost certainly significantly higher*

The U.S. government is the biggest single user of the Global Positioning System (GPS) and has invested at least \$43 billion in GPS infrastructure, equipment and services, according to a compilation of the limited number of available investment estimates. The actual total figure is almost certainly significantly higher. Current and future safety and efficiency benefits from GPS total at least \$132 billion.

While GPS is used by virtually every major federal department and agency, the number of publicly available statements and estimates of U.S. government investments in GPS is limited. It does not include investments by a number of departments and agencies, including heavy GPS users such as the Departments of Homeland Security, Agriculture and Energy, or full scale information on the Departments of Defense and Transportation, also heavy users of GPS.

With no uniform manner established in which to report federal government investments in GPS, along with varying time frames for those estimates which are available, arriving at valid figures is challenging. Nonetheless, this snapshot helps vividly illustrate how widespread and engrained the use of GPS, particularly high-precision GPS, is in the federal government. In addition to actual investment figures, the below also shows some of the the substantial safety and efficiency benefits of GPS. Those benefit estimates were offered in only some of the reports and, as with investment figures, the actual total is almost certainly significantly higher.

Many of the documents referenced below were submitted to the House Committee on Science, Space, and Technology, which had requested assessments from a wide range of federal department and agencies. Additional information was provided in hearing transcripts and a news story. In some instances, the below excerpts are lightly edited for continuity. All boldfacing in the following pages has been added by the Alliance.

## **Department of Defense Investments:**

While the Department of Defense (DOD) has not released a formal GPS investment study, it is clear from what is on the public record that DOD investments in GPS equipment are mammoth. So, while the information available on DOD costs is far from complete, the below gives a strong indication of the scope of DOD GPS investments.

In his written [testimony](#) for the September 15, 2011 House Subcommittee on Strategic Forces Armed Services Committee, Gen. William Shelton, head of the Air Force Space Command,

stated, “**As a Nation, we have invested roughly \$34 billion to field and operate the GPS constellation.** Clearly, it has become a global utility serving a worldwide user population.” General Shelton estimated that more than one million GPS receivers were in presently in use in the military.

In a June 23, 2011 hearing of the Committee on Transportation and Infrastructure Subcommittee on Aviation and the Subcommittee on Coast Guard and Maritime Transportation, Teresa M. Takai, DOD’s Chief Information Officer, testified:

“To deliver GPS service to all DOD and civil and commercial users who rely upon it, **DOD maintains and continuously** upgrades a constant constellation of 24 satellites composed of a minimum of four satellites in each six planetary orbits at a **very cost-effective budget currently of \$1.7 billion annually.**”

## **Department of Transportation (DOT) Investments:**

### **DOT Aviation Investments:**

**PLEASE NOTE:** The Aviation Impacts section of the following DOT section of this document contains material from both the FAA PowerPoint and the DOT Impact document. Unless the page citation specifically references the FAA, the page number cited is from the DOT Impact document.

- GPS safety enhancements are expected to prevent the loss of approximately 800 lives over the next 10 years, with an estimated public safety benefit of about **\$5 billion.***[pg 1]*
- GPS currently provides at least **\$200 million in efficiency benefits** for aviation each year, and an estimated minimum of **\$2 billion in efficiency benefits** over 10 years. *[pg 1]*
- GPS is also an essential building block in the ongoing deployment of the Next Generation Air Transportation System (NextGen), that builds upon current GPS-based capabilities. The FAA estimates the cumulative benefits of NextGen to be **\$23 billion** through 2018; and by 2030, the cumulative benefits grow to **\$123 billion** and reduce CO2 emissions by 64 million tons. *[pg 1]*
- There is broad investment in GPS technology throughout the industry:
  - 5,800 to 7,250 passenger, cargo and regional U.S. operated transport aircraft
  - 61,000 Instrument Flight Rules approved general aviation and air taxi aircraft
  - Majority of 310,000 pilots without instrument ratings use non-certified GPS units for situational awareness
- These **critical capabilities** rely on high-precision and GPS timing:
  - Airfield and Flight Procedure surveys
  - Flight test tracking
  - Space Weather monitoring
  - GPS Timing for computing resources and numerous mission critical systems, including
    - Terminal, enroute and oceanic automation systems

- Surveillance systems
- Voice communications and recoding systems
- Maintenance support systems [pg 14 FAA]
- FAA and aviation community **sunk costs** not Included in the estimate:
  - U.S. taxpayers have invested **\$3 billion** in FAA implementation of GPS and NextGen through FY11
  - Aviation industry investment in GPS equipment estimated to be **\$3 to \$4 billion**
  - Estimate does not include equiptage for thousands of DOD, Federal, State and local government public utility aircraft

### **DOT Rail Transportation Investments:**

- Freight railroads have begun to use the GPS data regarding train position and movement to enhance operational efficiency.
- Positive Train Control (PTC) systems serve to prevent train-to-train collisions, overspeed train derailments, incursions into roadway work zones, and accidents caused by railroad switches left in an incorrect position. [pg 2]
- All PTC systems require some form of transmission of PNT information. In 2009, the Federal Railroad Administration (FRA) estimated that the safety benefits alone of PTC system implementation could total **more than \$673 million over 20 years**. [pg 2]
- The FRA estimates that the sunk cost in PTC systems that rely on GPS is **more than \$1 billion dollars**, and that railroads plan an **additional \$4.3 billion** by December 31, 2015 in GPS-based PTC systems. Further, FRA has invested **\$65 million** on its **Automatic Track Inspection Program (A TIP)**. FRA owns five A TIP vehicles, which use **GPS to record the location** of track perturbations, including violations, defects and anomalies. [pg 2]

### **DOT Maritime Transportation Investments:**

- A conservative estimate provided by MARAD for all GPS-related equipment that is required to be on a vessel *greater* than 300 gross tons is \$100K per vessel. Including the vessels in the Ready Reserve Force (RRF) program with the U.S. commercial and coastal fleet, **this approaches \$500 million dollars** for currently installed GPS-related marine equipment. These costs are much higher if all inland commercial vessels that are less than 300 gross tons but still carry GPS receivers or other GPS related marine equipment were included. [pg 3]

### **DOT Highway Transportation Investments:**

- The Intelligent Transportation System (ITS) (JPO) has **invested several hundred million dollars** over the course of many years in safety-based research that requires GPS positioning to be effective. Considerable research investment has been made by both the federal government and the major automotive industry in connected vehicle safety research. [pgs 3-4]
- Going forward, DOT is planning to **invest approximately another \$100 million** in the Vehicle-to-Vehicle and Vehicle-to-Infrastructure related research that utilizes GPS positioning. [pgs 3-4]

### **Other DOT Investments:**

- The DOT-funded (inland or terrestrial) National Differential GPS System represent **\$71.8 million** in direct DOT funding for GPS-based infrastructure (FY 1998 - FY 2011). [pg 4]
- An additional **\$25 million** in funding has been provided state and local partners for specific site development for a total investment of approximately **\$97 million**. [pg 4]

## **National Oceanic and Atmospheric Administration (NOAA)**

### **Investments**

Source: *Written testimony of Ms. Mary Glackin, Deputy Under Secretary, National Oceanic and Atmospheric Administration, before the Committee on Science, Space, and Technology Hearing on "Impacts of the LightSquared Network on Federal Science Activities," Sept. 8, 2011*

Full transcript available [here](#).

- At least five major NOAA systems or functions require high-precision wideband GPS equipment, including systems that:
  - observe the Earth's atmosphere to improve global weather and climate models;
  - monitor sea level trends, measure atmospheric moisture to improve short-term weather forecasts;
  - inform surveyors and other customers about space weather conditions affecting GPS accuracy; and,
  - ensure compatibility among U.S. maps, surveys, and other geospatial products. [pg 4]
- Three of these five activities depend on NOAA's nationwide network of Continuously Operating Reference Stations (CORS) which collect and share precise data about GPS satellite orbits. CORS provides a consistent positioning technology, accurate to an inch, **used by millions of people throughout the United States, from surveyors to farmers to the FAA**. [pg 4]
- This network is critical to anchoring nautical charts, building roads and railways, surveying airports, and responding to natural disasters and other emergencies, such as Hurricane Katrina and the Deepwater Horizon oil spill. [pg 4]
- In the case of CORS alone, there are over 1,800 reference stations, many of which have multiple GPS receivers. [pg 4]
- This multi-million dollar investment has been made not only by NOAA, but more than 190 stakeholder organizations, including states, local communities, universities and other Federal Agencies. They all have a shared interest in maintaining a common standard for geospatial positioning in the United States, so the construction and maintenance of roads, bridges, railways, five inland waterways, and other projects that cross jurisdictional boundaries all use the same coordinate system. [pgs 4-5]

## **Department of Interior (DOI) Investments:**

Full document available [here](#).

- GPS is vitally important in acquiring virtually every type of spatially referenced data in use today. This includes aerial and satellite imagery, seismic networks, land surveys, engineering and scientific observation of all kinds. [pg 1]
- The DOI GPS Report estimates the Department has **invested between \$100 to \$200 million** in GPS technology. [pg 2]
- Estimating a tenfold return on this GPS investment, as put forward by some investigators, suggests that the Department has realized about **\$1-2 billion in benefits** from GPS. [pg 2]
- The Department continues to invest in GPS at the rate of about **\$12-24 million annually**. Again, assuming a factor of 10 for these benefits, there is an estimated annual return of **\$120 million - \$240 million**. [pg 2]

### **U.S. Geological Survey (USGS) Investments:**

Source: *Written Testimony of Dr. David Applegate, Associate Director, Natural Hazards, U.S. Geological Survey before the Committee on Science, Space, and Technology Hearing on "Impacts of the LightSquared Network on Federal Science Activities," Sept. 8, 2011*

Full testimony available [here](#).

- The Department estimates that it has **invested about \$100 million in the technology**. [pg 4]

### **Flooding/Waterway Management**

- GPS signals in mobile applications are used to accurately position flow-measuring equipment and obtain data needed to calibrate streamgages, which have radios that use the GPS timing signal to make near real-time transmission of data possible. [pg 2]
  - There are about 9,000 of these radios in use and they are essential for the accuracy of National Weather Service flood forecasts, which are used by flood-fighting agencies such as the Corps of Engineers to help minimize flood damage.
  - In turn, the forecasts are relied upon by states, the Bureau of Reclamation, and the Army Corps of Engineers to make timely water-management decisions.. [pg 2]
- Since 2009, the USGS has **invested \$11.5 million** in GPS-based satellite radios and 91 acoustic Doppler current profilers. [pg 2]

### **Earthquake, Volcano and Landslide Monitoring, Prediction and Prevention**

- Today, nearly all (mapping) data collected involves the use of GPS. All modern airborne or satellite-based systems are dependent on GPS for navigation, positioning and geolocation of the data. [pg 2]
- Ortho-rectified imagery needs GPS to reliably determine the location of each image. LiDAR technology, meanwhile, can determine elevation to within centimeters, but requires equally precise GPS positioning data to validate it. High-precision LiDAR data

can reveal hidden faults, map out ancient landslides, and determine the shape of volcanoes in unprecedented detail. Since 2008, USGS has made between **\$18 million and \$20 million** in LiDAR acquisition purchases per year. The **2010 total was over \$40 million.** *[pg2]*

- The ability of the USGS to monitor deformation of the Earth's crust requires the most precise, accurate, and reliable GPS signals. The USGS and its university cooperators, along with the National Science Foundation and UNAVCO consortium, **maintain and use over 1,000 permanent continuously operating GPS stations** to track plate motions and monitor ground deformation due to earthquakes along **faults like the San Andreas** and hundreds of others nationwide. *[pg 3]*
- Dense networks of high data rate, high-precision GPS stations are **particularly important for earthquake monitoring for at-risk urban areas in southern California, the San Francisco Bay Area, and the Pacific Northwest.** *[pg 3]*
- The estimated **capital cost** of the USGS investment in these geodetic networks is **\$26 million**. For the NSF Earthscope project alone, GPS network **capital costs are about \$100 million** and current operation and **maintenance costs are \$11 million yearly**. The USGS capital investment in GPS receivers currently used for volcano monitoring is **\$3.5 million.** *[pg 3]*

# # #